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CONCRETE PAVEMENT

FOR

MONTANA'S *Interstate Highway System*

422

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Montana
Interstate System

Reasons For More Concrete
On The Interstate Highway System

1. New Requirements For Heavier Design
2. Progressive Reduction In Bid Prices
3. Lower Total Cost
4. Recognition of Local Industry

REASONS FOR MORE CONCRETE ON THE INTERSTATE SYSTEM

1) NEW REQUIREMENTS FOR HEAVIER TRAFFIC

New Federal legislation for the Interstate System, adopted in late 1963, requires that all future roadway design be based on estimated traffic for twenty years from the date of design. Previous Interstate design was based on 1975 traffic.

Roadway designs being engineered in 1964 will be based on estimated traffic for the year 1984. Projects engineered in 1970 will be based on traffic for 1990.

Results of the AASHO Test Road are included in this report to document the adequacy of concrete pavement design for the heavier traffic.

2) PROGRESSIVE REDUCTION IN BIDS

An analysis of unit bid prices on the Interstate System as received by the Montana State Highway Department 1958 to 1964 indicate a progressive reduction in construction costs for concrete paved Interstate Highways. Cost reductions by year, and costs influenced by the size of projects are analyzed.

3) LOWER TOTAL COST

The cost of a highway should be analyzed on the total cost of the roadway over the life of the pavement. Cost comparisons as used by Wyoming, Colorado and New Mexico - to determine the total cost of the roadway - are included in this report.

THE AASHO ROAD TEST PROVIDED VALUABLE INFORMATION ON THE EFFECT OF VARYING AXLE LOADS ON DIFFERENT TYPES OF PAVEMENT.

COMPARABLE DESIGNS CAN BE EXAMINED, PERFORMANCE INVESTIGATED AND COST ANALYSIS PREPARED USING MONTANA UNIT PRICES.

MONTANA STATE HIGHWAY DEPARTMENT DESIGNS, NOW BEING USED, CAN BE EVALUATED AND STUDIED TO DETERMINE WHAT MODIFICATIONS ARE NEEDED TO COMPLY WITH THE LATEST BUREAU OF PUBLIC ROADS AND AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS CRITERIA FOR ANTICIPATED TRAFFIC - 20 YEARS FROM DATE OF DESIGN.

CONCRETE IS PREFERRED ON THE NATIONAL INTERSTATE SYSTEM

Records as of March 31, 1964 show that portland cement concrete has been specified for 58 per cent of the construction awards on the entire Interstate System.

Asphalt pavement awards totaled 42 per cent, however, concrete base or cement-treated base was specified on one-fourth of these asphalt paving awards.

CONCRETE IS PREFERRED FOR HIGHWAYS WHERE HEAVY TRAFFIC IS ANTICIPATED

Concrete is Preferred on The Nation's Interstate System

Construction Awards

July 1, 1956 - March 31, 1964

Type	Miles	Percent
Concrete	9,125.9	58
Asphalt	4,958.7	31.5
Asphalt (Concrete or Cement Treated Base)	1,672.5	10.5
Total Asphalt	6,631.2	42
Total To 3/31/64	15,757.1	100

On LOOP 5, surviving designs - concrete and asphalt - are examined in the adjoining chart. On the basis of the Road Test Rating System, the concrete design outperformed both asphalt designs. When the cost of each design is determined by using 1964 Montana average unit prices, concrete is only slightly higher in initial cost than the cost of the acceptable asphalt design.

CONCRETE PAVEMENTS COST NO MORE

than other types of pavements when both are designed

FOR INTERMEDIATE WEIGHT AXLE LOADS

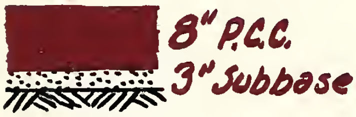
MONTANA
INTERSTATE SYSTEM

CONCRETE PAVEMENT COSTS NO MORE
THAN OTHER TYPES OF PAVEMENT WHEN BOTH ARE DESIGNED
FOR THE SAME AXLE LOAD

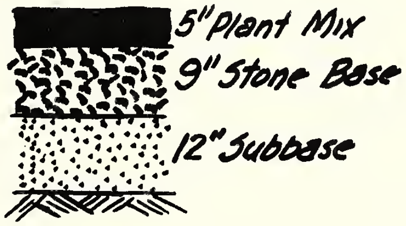
Results On The AASHO Test Road - Loop No. 5

22,400 lb. Single Axle
40,000 lb. Tandem Axle
1,114,000 Load Repetitions

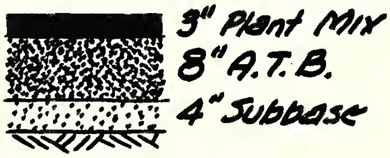
Concrete



Asphalt with Crushed Stone Base



Asphalt with Asphalt Treated Base



Rating At End Of Test

4.0 and above - Very Good

4.2

3.5

3.0

8" CONCRETE PAVEMENT PERFORMED BETTER THAN THE OTHER DESIGNS

ESTIMATED COST PER MILE (4 LANE)

BASED ON AVERAGE UNIT BID PRICES - MSHD - 1964

$141,504

$134,323

$152,908

On LOOP 6, surviving designs - concrete and asphalt - are examined in the adjoining chart. On the basis of the Road Test Rating System, the concrete design outperformed both asphalt designs. The initial cost of the concrete highway is less than either asphalt highway (based on 1964 Montana State Highway Department average unit prices).

The initial cost of concrete is much less than a comparable design of asphalt-treated base when constructed to AASHO Road Test standards. Construction procedures which are generally specified for plant-mix surfacing were specified for placement of the asphalt-treated bases (2-3 inch lifts) on the Road Test. The quality of the asphalt-treated base was very good - having a Marshall Stability of 1650 - higher than the quality used on many plant-mix surfaces today.

CONCRETE PAVEMENT COSTS LESS

than other types of pavements when both are designed

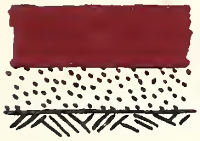
FOR HEAVY AXLE LOADS

MONTANA
INTERSTATE SYSTEM

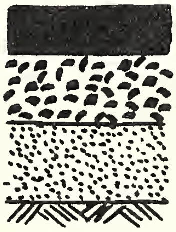
CONCRETE PAVEMENT COSTS NO MORE
THAN OTHER TYPES OF PAVEMENT WHEN BOTH ARE DESIGNED
FOR THE SAME AXLE LOAD

Results On The AASHO Test Road - Loop No. 6
30,000 lb Single Axle 48,000 lb Tandem Axle
1,114,000 Load Repetitions

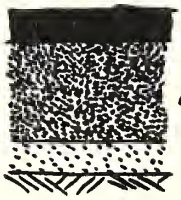
Concrete



Asphalt
with Crushed Stone Base



Asphalt
with Asphalt Treated Base



Rating At End of Test

3.9	2.8	3.7

8" CONCRETE PAVEMENT PERFORMED BETTER THAN THE OTHER DESIGNS

ESTIMATED COST PER MILE (4-LANE)
BASED ON AVERAGE UNIT BID PRICES - MSHD - 1964

$146,250	$146,678	$219,426

An evaluation of the Montana State Highway Department's current design for concrete (8" concrete-4.8" cement-treated subbase - 7.2" gravel) based on the equivalent 18,000-lb. axles with AASHO Road Test LOOP 5 and LOOP 6 clearly indicates that the design is adequate for the new BPR and AASHO 20-year traffic criteria.

The maximum traffic based on 1962 Montana traffic studies is about 10,000 ADT with most of the Interstate System carrying less than 5000 ADT. A 20-year projection of this Montana traffic would be less than the traffic on LOOP 6 but greater than that on LOOP 5.

Repeated laboratory tests and field investigations have documented that an 8-inch plain concrete pavement on 4-inch cement-treated base has better load carrying capabilities than 8-inch plain concrete on 6 inches of untreated base (as used on the test road).

The Montana design currently calls for 4.8-inches cement-treated subbase plus 7.2-inches of gravel. AASHO Test Road data clearly shows that the design is more than adequate for Montana's traffic.

MONTANA
INTERSTATE SYSTEM

MONTANA HIGHWAY DEPARTMENT DESIGN:

8" CONCRETE PAVEMENT ON 4.8" CEMENT TREATED SUBBASE

DESIGN EVALUATION IN TERMS OF 18,000 LB. AXLES

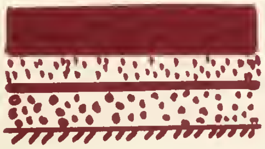
AASHO ROAD TEST (1,114,000 LOAD APPLICATIONS)

		EQUIVALENT 18,000# AXLES	
		TOTAL	PER DAY OVER 20 YEARS
LOOP 5	22,000# SINGLE	2,750,000	377
	40,000# TANDEM	3,960,000	542
LOOP 6	30,000# SINGLE	8,690,000	1190
	48,000# TANDEM	8,100,000	1110

MONTANA TRAFFIC

10,000 ADT (1962)		
20 YEAR PROJECTION =	7,665,000	1050
3000 ADT (1962)	2,300,000	315
5000 ADT (1962)	3,832,000	525

PRESENT MONTANA DESIGN ADEQUATE FOR 20 YEAR TRAFFIC CRITERIA



The average low bids on concrete pavement have decreased from $5.00 per sq.yd. in 1960 to $3.62 per sq.yd. in the first half of 1964. (Montana Interstate Projects).

The last cost estimate for completing the Interstate System was made in 1960. The 1965 estimate, now being made, can reflect this significant reduction in concrete paving costs.

Similar cost reductions have been noted in Wyoming, Colorado and New Mexico, however, the downward trend of PCC costs in Montana is more pronounced.

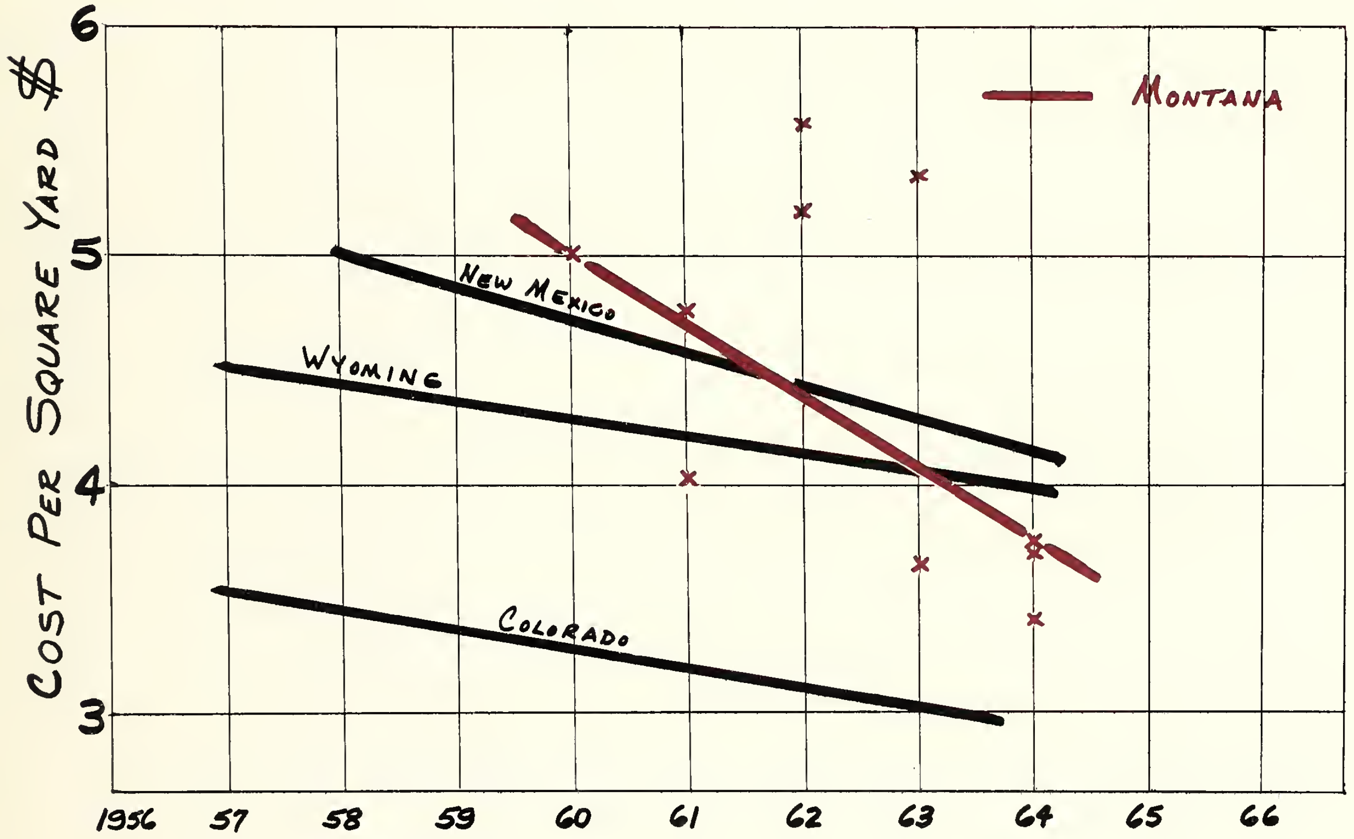
As more concrete pavement is specified by the Montana State Highway Department - a continued reduction in bid prices should be realized.

When Montana has a continuous yearly concrete paving awards record of the same duration as Colorado it is a logical assumption that the Montana low bids for concrete pavement should equal that of Colorado - resulting in an additional saving of $10,000 per 4-lane mile.

MONTANA
INTERSTATE SYSTEM

CONCRETE PAVING COSTS

1956-1964



THE PROGRESSIVE REDUCTION IN BID PRICES FOR CONCRETE - 1960-1964 - EQUALS A COST REDUCTION OF

$38,860 PER MILE (4-LANE)

To complete the Montana Interstate System by 1972, larger projects will be awarded to contract during the next few years.

An analysis of all concrete paved Montana Interstate projects shows a significant decrease in cost as the size of projects is increased.

The average unit low bid for a square yard of concrete pavement based on the size of the project is plotted on the adjoining chart.

The average low bid on projects less than 75,000 square yards was $5.10 per square yard. Projects involving more than 200,000 square yards of concrete were bid at an average cost of $3.60 - with individual bids as low as $3.30 per square yard.

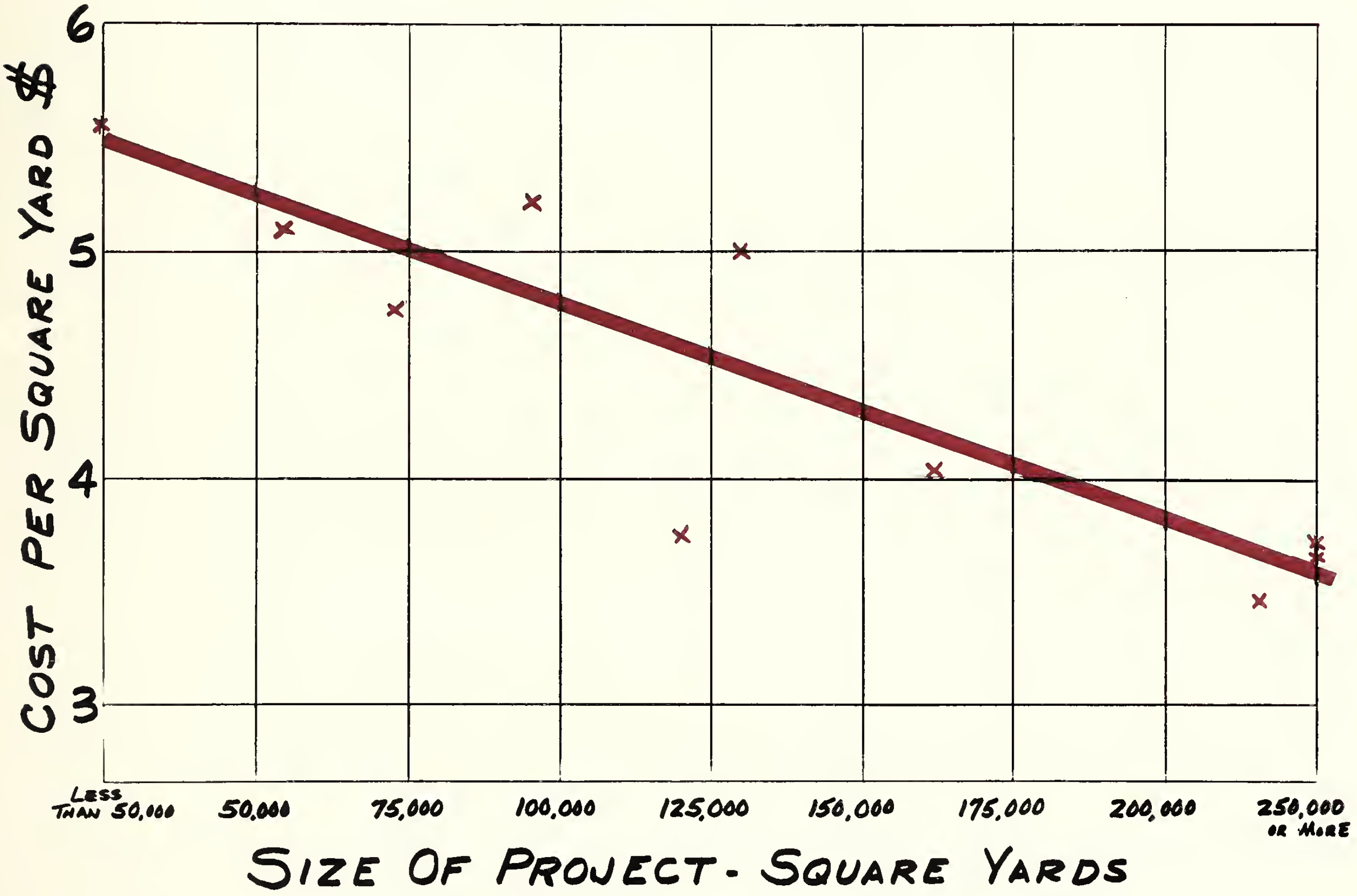
THE LARGER THE PROJECT

THE LOWER THE CONCRETE PAVING COST

CONCRETE PAVING COSTS

INFLUENCED BY SIZE OF PROJECT

MONTANA SHD



THE LARGER THE PROJECT -
THE LOWER THE COST

An analysis of all Montana Interstate projects indicates that concrete highways have decreased in cost some $38,860 per mile (4-lane). During the same period the cost of blacktop highways has increased by $10,920 per mile (4-lane).

The cost of concrete highways is continually being reduced as more contractors become familiar with modern concrete paving operations.

The increased cost of asphalt highways being observed in Montana is similar to trends noted in other states. Increased traffic estimates based on AASHO Road Test data call for increased total depths in blacktop design. Three-bin asphalt mixtures (Type 3), specified for Interstate Highway construction in Montana since 1961 has increased the cost of flexible pavements. The cost of plant mix has increased from $2.87 per ton in 1960 to $4.04 per ton in the first half of 1964 (based on MSHD average unit bid prices). Thicker asphalt surfaces are being recommended based on the AASHO Road Test, therefore, additional increases in the cost of asphalt pavements may be anticipated.

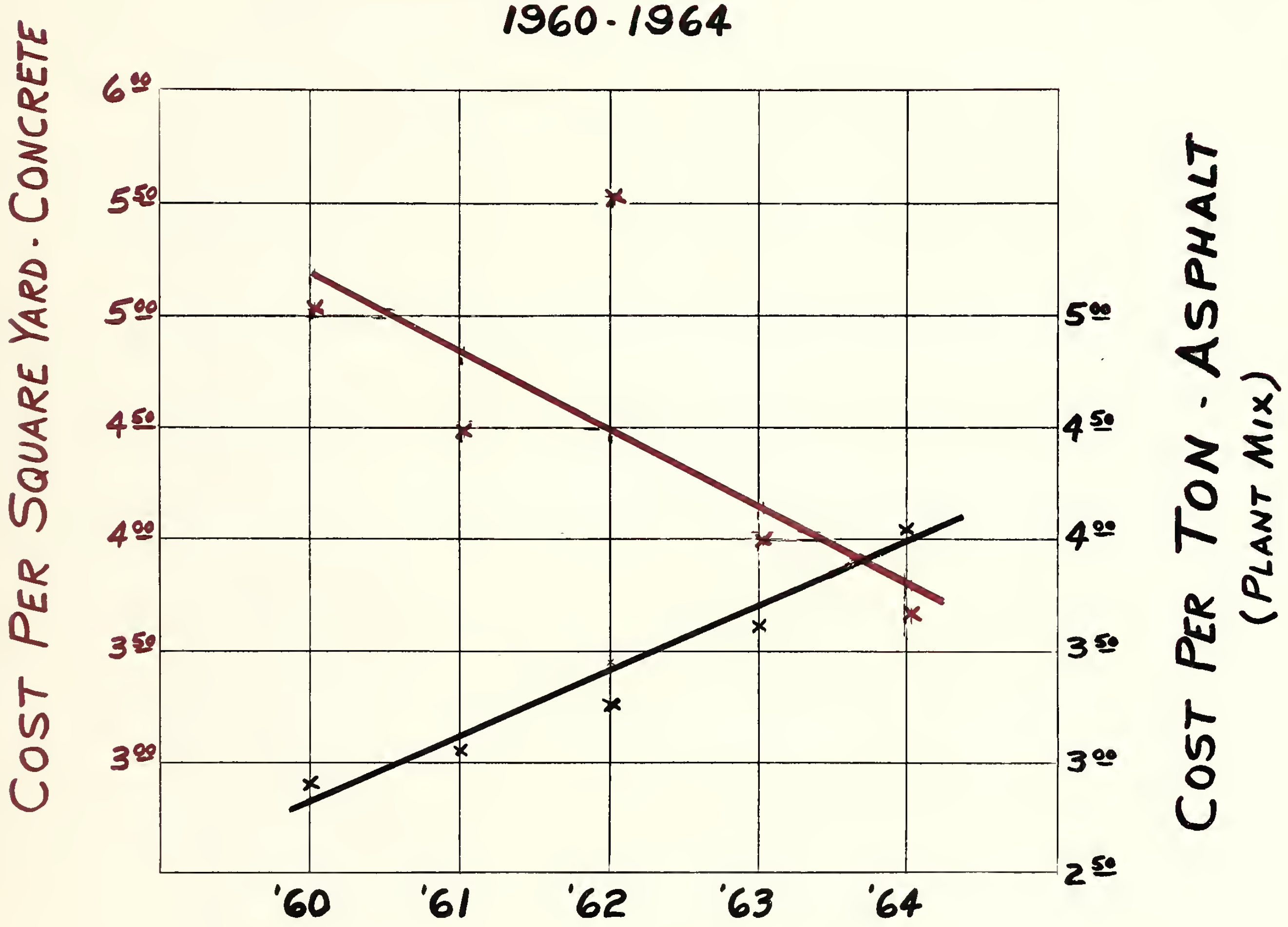
The cost of concrete per square yard and the cost of plant mix per ton are plotted on the adjoining chart. The first cost difference (4-lane mile) has been reduced by some $49,780 during the 4-year period.

MONTANA
INTERSTATE SYSTEM

INTERSTATE MONTANA 15

INTERSTATE HIGHWAY COSTS
MONTANA SHD

1960-1964



PCC COST REDUCTION IN PERIOD = $38,860.00 PER 4-LANE MILE

ASPHALT COST INCREASE IN PERIOD = 10,920.00 PER 4-LANE MILE

FIRST COST DIFFERENCE REDUCED BY $49,780.00 PER 4-LANE MILE

CONCRETE IS COMPETITIVE IN FIRST COST

The AASHO Guide on Project Procedures published in 1960 suggests procedures for paving type determination and documentation.

In the paragraph pertaining to cost comparisons, the guide suggests...."a better and more realistic measure would be the cost on the basis of service life or service rendered by a pavement structure. Such cost computations should reflect original investment, anticipated life, maintenance expenditures, and salvage value."

THE TOTAL COST OF A PAVEMENT SHOULD BE AN IMPORTANT FACTOR IN PAVEMENT DETERMINATION.

The adjoining chart shows the procedure followed by the Wyoming State Highway Department to document the request for concrete pavement on a section of I-90 near Buffalo. The project was originally programmed for blacktop.

Although the initial cost for concrete pavement exceeded the cost of blacktop, the total cost for a 30 year period was about the same.

Wyoming concluded its justification to BPR with a listing of the "plus advantages" for concrete pavement. The BPR office in Cheyenne, as well as the Regional BPR office in Denver, approved concrete pavement - now under construction.

THE "TOTAL COST" INCLUDES MAINTENANCE COSTS FOR BOTH TYPES OF PAVEMENT - AND THE PERIODIC SEAL COATS REQUIRED FOR BLACKTOP SURFACES.

ANNUAL COST ANALYSIS

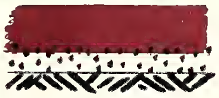
Approved By The Bureau of Public Roads
Division And Regional Offices

WYOMING STATE HIGHWAY DEPARTMENT

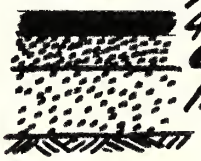
INTERSTATE 90 EAST OF BUFFALO FOUR LANE

Comparative Designs

Concrete



Blacktop



	Concrete	Blacktop
Construction Cost	$179,921.28	$165,601.92
Routine Maintenance		
Concrete $320/mile/year × 30	9,600.–	
Blacktop $460/mile/year × 30		13,800.–
Seal Coats 5 @ $2,000		10,000.–
TOTAL COST - 30 YEARS	$189,521.28	$189,401.92

WYOMING REQUESTED AND WAS GRANTED BPR APPOVAL SINCE:

1 "very little difference in cost"

2 "far greater salvage value in the concrete pavement"

3 "added safety features
light reflectivity
greater skid resistance"

4 "minimum of maintenane with concentrated traffic"
(fewer complaints by traveling public)

Colorado State Highway Department makes similar studies for the Interstate System - to determine studies for the Interstate System - to determine the total pavement cost.

Colorado estimates a concrete highway will provide adequate service for 28 years with minor routine maintenance during the life of the pavement.

A lower initial cost asphalt highway could be constructed - but the state would be burdened with costly maintenance during the life of the pavement. A 2-inch overlay would be needed to have the blacktop roadway equal the life expectancy of the concrete. Maintenance data are realistic figures determined by the Colorado Department.

Although the details of total cost studies vary from State to State - the basic data is similar. Colorado prepares Total Cost Analysis of this type for each Interstate Project and includes it with other papers when requesting approval from the Bureau of Public Roads. This has been standard practice since 1956.

ALL COSTS FOR A PAVEMENT STRUCTURE DURING THE LIFE OF THE PAVEMENT SHOULD BE DETERMINED

ANNUAL COST ANALYSIS

Approved By The Bureau of Public Roads
Division and Regional Offices

COLORADO STATE HIGHWAY DEPARTMENT

TYPICAL ANALYSIS FOR INTERSTATE PROJECTS

PLAN No. 1

8" Concrete Pavement – 6" Subbase – – 28 Year Life
Maintenance $175 per mile per year (2-Lane)

Initial Construction Cost	$\$75,885^{34}$	
Maintenance ($175 × 28)	$4,900^{00}$	
TOTAL COST – 28 YEARS	$\$80,785^{34}$	per mile

PLAN No. 2

4" Asphalt Surface – 4" Base – 4" To 15" Subbase
14 Year Life + 2" Overlay For 28 Year Life
Maintenance $300 per mile per year (2-Lane)

Initial Construction Cost	$\$51,577^{93}$	
Maintenance ($300 × 28)	$8,400^{00}$	
Seal Coats ($\$1,454^{87}$ × 7)	$10,184^{09}$	
1 Second Story (2" Thick)	$18,391^{65}$	
TOTAL COST – 28 YEARS	$\$88,553^{67}$	per mile

NET DIFFERENCE IN FAVOR OF CONCRETE: 8.8%

The New Mexico State Highway Department made a total cost study for one section of the Interstate System.

The total cost was divided by the life expectancy to determine a "Cost Per Year". In this case, the concrete pavement was estimated to cost less per year - and is now serving the heavy Interstate 10 traffic.

The importance of realistic estimates should be emphasized. The first cost for concrete pavement on this project was estimated to be $86,495 per mile (2-lane). The actual low bid was $65,371 per mile - more than $20,000 under the estimate.

The low bid indicates the total 30 year cost of the pavement will be about $71,000 per mile - or $2,350 per mile per year.

ANNUAL COST ANALYSIS

Approved By The Bureau of Public Roads
Division and Regional Offices

NEW MEXICO STATE HIGHWAY DEPART.

INTERSTATE PROJECT
2-LANE

8" Concrete Pavement - 4" Cement Treated Subbase
4' and 10' Shoulders (Plant Mix) 30 Year Life

First Cost	$\$86,495^{35}$
Maintenance ($\$175$/mi/yr. × 30)	5250^{00}
TOTAL COST	$91,745^{35}$

COST PER YEAR $\frac{91,745^{35}}{30} = \$3,058^{17}$ per mile

5" Plant Mix - 6" Cement Treated Base
4' and 10' Shoulders 20 Year Life

First Cost	$\$58,557^{00}$
Maintenance ($\$300$/mi./yr. × 20)	$6,000^{00}$
Seal Coats (One in five years and every three years thereafter)	$10,800^{00}$
TOTAL COST	$75,357^{00}$

COST PER YEAR $\frac{\$75,357^{00}}{20} = \$3,767^{85}$ per mile

No annual cost studies have been made by the Montana State Highway Department. Using 1964 average bid prices and the standard design currently being used by the Department an analysis was prepared by the Montana District.

Maintenance costs for concrete pavements in Montana are not available. The same figure was used for both pavement types, which is undoubtedly quite conservative for asphalt pavements. A cost study made by the Montana State Highway Department for a five-year period (1951-1955) showed an average surface maintenance cost of $656 per two-lane mile per year for asphalt pavements. (See appendix for comparable maintenance costs on the Oklahoma and Indiana Legislative Test Roads which have approximately the same traffic volume as that anticipated in Montana within 20 years). Maintenance funds saved are future state matching funds.

The seal coat cost ($2,278 per two-lane mile) is an average cost of seal coat projects awarded by the Montana State Highway Department during 1963 and 1964. The initial seal coat which is generally placed a year after construction is included in the initial cost of the asphalt pavement. Additional seal coats are anticipated every five years.

No additional plant mix surfacing is anticipated in the 20-year life of the flexible pavement - however, maintenance records on the Indiana and Oklahoma Test Roads show that surfacing is required much sooner than 20 years after initial construction. Resurfacing was required during the ninth year on the Indiana Test Road and during the sixth year on the Oklahoma project. (See Appendix).

A 30-year life for concrete and 20-year life for asphalt pavement has been approved by the local Bureau of Public Roads Division and Regional Offices.

Concrete will provide a net saving of $2000 per 4-lane mile in annual road user costs for the "MONTANA TAXPAYER".

ANNUAL COST ANALYSIS

MONTANA INTERSTATE PROJECT

4-LANE

8" CONCRETE - 4.8" CEMENT TREATED BASE - 7.2" GRAVEL

4' AND 10' SHOULDERS (PLANT MIX) 30 YEAR LIFE

FIRST COST	$174,662.00
MAINTENANCE ($350/MILE/YEAR)	10,500.00
TOTAL COST	185,162.00

COST PER YEAR $\frac{\$185,162}{30}$ = $6,172.00 PER MILE

4" PLANT MIX ASPHALT - 24.8" BASE & SUBBASE

4' & 10' SHOULDERS (PLANT MIX) 20 YEAR LIFE

FIRST COST	$143,083.00
MAINTENANCE ($350/MILE/YEAR)	7,000.00
SEAL COATS (EVERY FIVE YEARS-6-11-16)	13,368.00
TOTAL COST	163,451.00

COST PER YEAR $\frac{\$163,451}{20}$ = 8,172.50 PER MILE

NET SAVING WITH CONCRETE

$2000.50 PER MILE/YEAR

A thorough study of all uncompleted portions of the Interstate System in Montana was completed by the Montana District. The study included anticipated traffic, based on 1962 MSHD traffic studies; subgrade (and ground water table) evaluation; and availability of suitable materials for concrete pavement.

At least nine areas of the state have a combination of important engineering factors that indicate the use of concrete pavement is most logical.

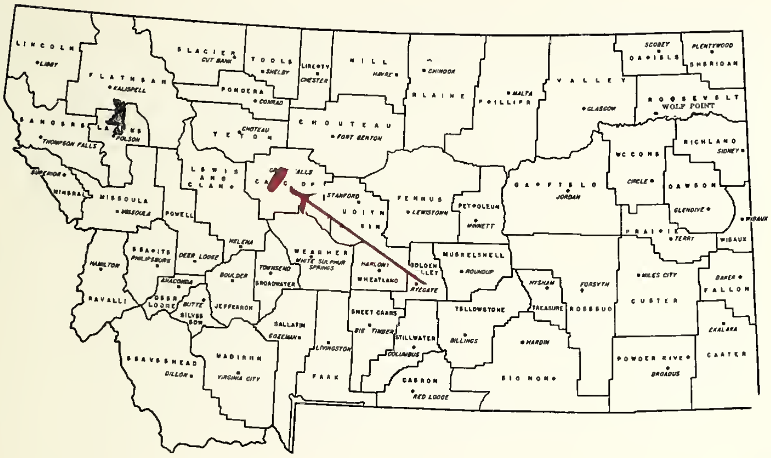
Interstate 15 west of Great Falls to Ulm, is one section analyzed. Comparable designs were determined based on local soil conditions and results of the AASHO Test Road. (The gravel subbase is not included in this project due to subgrade conditions).

The construction cost for a mile of 4-lane pavement was determined by using average unit prices on projects submitted on recent construction in the area.

The TOTAL COST includes construction cost and anticipated maintenance for a 30-year life of the pavement.

MONTANA
INTERSTATE SYSTEM

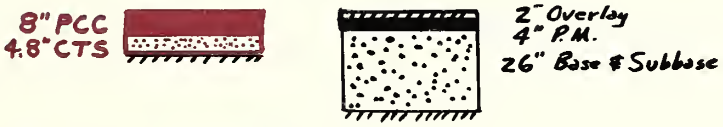
ADDITIONAL CONCRETE PAVING
I-15
GREAT FALLS - ULM
7.0 MILES



1. HEAVY TRAFFIC 14,400 ADT (1984)
2. LONG AGGREGATE HAUL - LESS REQUIRED FOR CONCRETE
3. CONNECTS WITH CONCRETE PROJECT

Comparative Designs

Concrete Asphalt



COST ESTIMATE - 4-LANE MILE

	Concrete	Asphalt
INITIAL CONSTRUCTION COST	$166,690-	$146,668-
MAINTENANCE COSTS (30 YEAR)		
CONCRETE ($350 x 30)	10,500-	
ASPHALT ($350 x 30)		10,500-
FUTURE OVERLAY - ASPHALT (2")		16,000-
SEAL COATS (EVERY FIVE YEARS) (6-11-16-21-26) ($4456.00)		22,280-
TOTAL COST	$177,190-	$195,448-

TOTAL SAVINGS WITH CONCRETE ON PROJECT - $128,000.00

Similar studies were made for nine areas of the state using average bid prices on some projects and estimating bid prices in other areas where concrete has not been used:

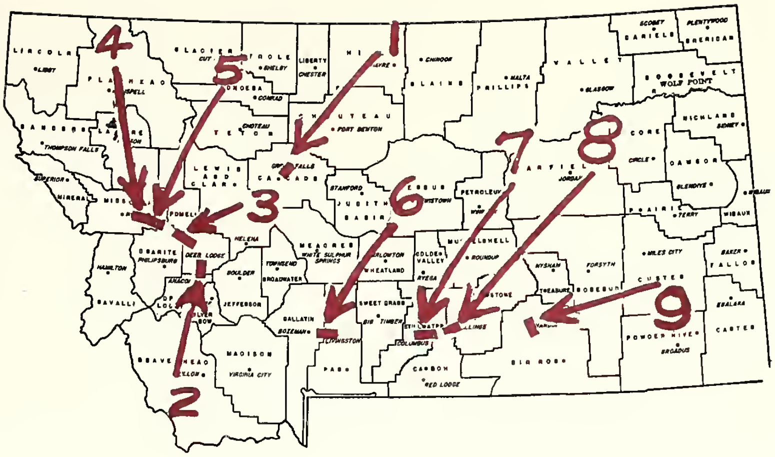
1. I-15, Great Falls - Ulm - 7.0 Miles
2. I-90, Warm Springs East & West - 11.0 Miles
3. I-90, Gold Creek - Race Track - 19.0 Miles
4. I-90, Clinton, E & W - 15.1 Miles
5. I-90, Bearmouth, E & W - 16.9 Miles
6. I-90, Bozeman Pass, E&W - 12.1 Miles
7. I-90, Columbus, E & W - 18.3 Miles
8. I-90, Park City - West to Laurel - 15.9 Miles
9. I-90, Hardin, N & S - 15.0 Miles

Most projects are 4-lane and in areas having reasonably high traffic for Montana.

The construction cost of concrete is slightly higher, however, the total cost is important. These 130.3 miles will save the Montana taxpayer some $3 million.

If gravel subbase is required on four projects this would increase the initial cost of the PCC pavement by some $20,000 per mile - however, concrete would still save some $1.5 million on the 130.3 miles.

MONTANA INTERSTATE SYSTEM



ADDITIONAL CONCRETE PAVEMENT

INTERSTATE HIGHWAY SYSTEM

130.3 MILES

PROJECT No.	MILES	CONCRETE TOTAL COST 4-LANE MILE	ASPHALT TOTAL COST 4-LANE MILE	SAVINGS PER 4-LANE MILE	TOTAL PROJECT SAVINGS
1	7.0	$177,190	$195,448	$18,258	$128,000
2*	11.0	163,775	195,448	31,673	349,000
3*	19.0	163,775	191,863	28,088	535,000
4	15.1	163,775	191,863	28,088	423,000
5	16.9	177,190	191,863	14,673	275,000
6	12.1	177,190	195,448	18,258	220,000
7*	18.3	163,775	195,448	31,673	580,000
8*	15.9	163,775	195,448	31,673	500,000
9	15.0	177,190	183,103	5,913	88,000
	130.3				$3,098,000

CONCRETE PAVEMENT WILL SAVE TAXPAYERS MORE THAN $3 MILLON ON 130 MILES

* IF GRAVEL BASE IS CONSIDERED NECESSARY ON THESE PROJECTS THE SAVINGS WOULD BE LESS, BUT STILL OVER $1.5 MILLION ON THE 130.3 MILES.

SUMMARY

The additional 130 miles of concrete pavement is a logical conclusion based on reliable engineering and cost data. These are, however, the most obvious projects, but further study at this time might indicate more mileage should be considered for concrete pavement.

To date some 95 miles of concrete has been programmed for the Montana Interstate System involving some 1187 miles. The additional mileage added to that already programmed would result in some 225 miles or only 19 per cent of the system. This figure is rather conservative considering asphalt pavements are used extensively on the primary and secondary systems in Montana.

CONCRETE PAVEMENTS COST NO MORE

than other type pavements

WHEN COMPARABLE DESIGNS ARE SPECIFIED

REMEMBER THE FOLLOWING QUOTATION:

"It's unwise to pay too much - but it's worse to pay too little. When you pay too much, you lose a little money - that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business prohibits paying a little and getting a lot - it can't be done."

John Ruskin

ANALYSIS OF NINE PROJECTS CONSIDERED FOR PCC PAVING.............

Project No. 1 I-15,Great Falls-Ulm 7.0 Miles
Award scheduled for July 1966.
Connects with Great Falls West Side PCC project using concrete. Long haul on aggregates - less used for PCC paving. Bids about $4.00/sq.yd.

TRAFFIC: 1962 - 4798 ADT
1984 - 14,400 ADT
432 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 26" Base
CONSTRUCTION COST	$166,690	$146,668
TOTAL 30 Yr. SURFACING COST	$177,190	$195,448
TOTAL SAVINGS PER MILE	$ 18,258	
TOTAL SAVINGS ON PROJECT	($18,258 x 7.0) =	$128,000

Project No. 2 I-90, Warm Springs - E&W 11.0 Miles
Scheduled for award - February 1969.
High water table. Good concrete aggregates and non-swelling subgrade. Bids expected about $3.60/sq.yd.

TRAFFIC: 1962 - 2456 ADT
1984 - 7400 ADT
221 18^k/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 26" Base
CONSTRUCTION COST	$153,275	$146,668
TOTAL 30 Yr. SURFACING COST	$163,775	$195,448
NET SAVINGS PER MILE	$ 31,673	
NET SAVINGS ON PROJECT	$349,000	

Project No. 3

Gold Creek-Race Track (Combine three projects) 19.0 Miles
Scheduled for award September 1967 - March and February 1968.
Good aggregates. Bids about \$3.60/sq.yd.
High water table in area of these projects.

TRAFFIC: 1962 - 2660 ADT
1984 - 8000 ADT
240 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 25" Base
CONSTRUCTION COST	\$153,275	\$143,083
TOTAL 30 Yr. SURFACING COST	\$163,775	\$191,863
NET SAVINGS PER MILE	\$ 28,088	
NET SAVINGS ON PROJECT	\$535,000	

Project No. 4

Clinton E&W 15.1 Miles
Award scheduled December 1966.
Good aggregates. High water table.
Estimate bids at \$3.60-\$3.70/sq.yd.

TRAFFIC: 1962 - 2275 ADT
1984 - 6825 ADT
205 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 25" Base
CONSTRUCTION COST	\$153,275	\$143,083
TOTAL 30 Yr. SURFACING COST	\$163,775	\$191,863
NET SAVINGS PER MILE	\$ 28,088	
NET SAVINGS ON PORJECT	\$423,000	

Project No. 5 Bearmouth E&W (Two projects) 16.9 Miles
Award scheduled in September and
May 1965. High water table. Medium
traffic. Estimate bids at $4.00/sq.yd.

TRAFFIC: 1962 - 2275 ADT
1984 - 6825 ADT
205 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 24" Base
CONSTRUCTION COST	$166,690	$143,083
TOTAL 30 Yr. SURFACING COST	$177,190	$191,863
NET SAVINGS PER MILE	$ 14,673	
NET SAVINGS ON PROJECT	$275,000	

Project No. 6 Bozeman Pass-E&W (Two projects) 12.1 Miles
Award scheduled for April 1969.
PCC pavement is used on all mountain passes in Washington for ease of maintenance.
This would provide section for obtaining future records of maintenance of PCC on mountain passes.
Concrete aggregates available. Bids estimated at $4.00/sq.yd.

TRAFFIC: 1962 - 2648 ADT
1984 - 7950 ADT
240 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 26" Base
CONSTRUCTION COST	$166,690	$146,668
TOTAL 30 Yr. SURFACING COST	$177,190	$195,448
NET SAVINGS PER MILE	$ 18,258	
NET SAVINGS ON PROJECT	$220,000	

Project No. 7 Columbus E&W (Two projects) 18.3 Miles
Award scheduled in June-July 1967.
High water table in this area. Good concrete aggregates available. Bids estimated at $3.60/sq.yd.

TRAFFIC: 1962 - 2115 ADT
1984 - 6350 ADT
200 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 26" Base
CONSTRUCTION COST	$153,275	$146,668
TOTAL 30 Yr. SURFACING COST	$163,775	$195,448
NET SAVINGS PER MILE	$ 31,673	
NET SAVINGS ON PROJECT	$580,000	

Project No. 8 Park City-West & Park City-Laurel 15.9 Miles
Award scheduled in December 1968 and November 1965. High water table. Medium traffic. Good concrete aggregates. Bids estimated at $3.60/sq.yd.

TRAFFIC: 1962 - 2355 ADT
1984 - 7065 ADT
210 18^k Loads/day

	CONCRETE	ASPHALT
	8" PCC 4.8" CTB	4" P.M. 26" Base
CONSTRUCTION COST	$153,275	$146,668
TOTAL 30 Yr. SURFACING COST	$163,775	$195,448
NET SAVINGS PER MILE	$ 31,673	
NET SAVINGS ON PROJECT	$500,000	

Project No. 9 Hardin N&S 15.0 Miles

Award scheduled in November 1965.
High water table in some areas. Bids estimated at $4.00/sq.yd.

TRAFFIC: 1962 - 2683 ADT
1984 - 8049 ADT
240 18^k Loads/day

	CONCRETE	ASPHALT
DESIGN	8" PCC 4.8" CTB	4" P.M. 22" Base
CONSTRUCTION COST	$166,690	$134,323
TOTAL 30 Yr. SURFACING COST	$177,190	$183,103
NET SAVINGS PER MILE	$ 5,913	
NET SAVINGS ON PROJECT	$ 88,000	

APPENDIX

MAINTENANCE COSTS

Indiana Legislative Test Road

Built 1953

1962 Traffic: 490-505 equivalent 18^k Loads/day

ASPHALT (7.14 Miles)

	Total Per Mile	Per 2-Lane Mile/Yr.
Eight-Year Costs	$ 360.67	$ 45.08
Resurface - Ninth Year	$5,326.58	--
Nine-Year Costs	$5,687.25	$631.91

CONCRETE (6.70 Miles)

Eight-Year Costs	$ 38.74	$ 4.31
Ninth Year	--	--
Nine-Year Costs	$ 38.74	$ 4.31

Oklahoma Legislative Test Road

Built 1955

1963 Traffic: 7650 ADT
Actual Count of 571 Heavy Commercial Vehicles/Day

ASPHALT (4.0 Miles)

	Total Project	Per 2-Lane Mile/Yr.
Five-Year Costs	$ 1,591.87	$ 79.59
Resurface - Sixth Year (1½")	$45,361.49	--
Six-Year Costs	$46,953.36	$2,347.66

CONCRETE (4.0 Miles)

Six-Year Costs	$ 557.83	$ 27.89